淡江大學八十八學年度日間部轉學生招生考試試題

系別：物理系三年級　　科目：電磁學

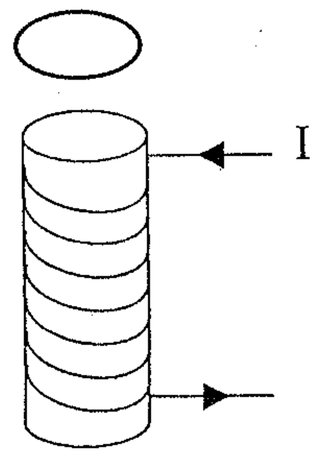
◆ 詳列或敘述計算過程，含公式與算式，否則不予計分。

1. One of these is an impossible electrostatic field. Which is the one? And why? (10 %)
   (a) $\boldsymbol{E} = c\,[(z^2)\,\mathbf{i} + (xy^2)\,\mathbf{j} + (2xz)\,\mathbf{k}]$
   (b) $\boldsymbol{E} = c\,[(x^2+y^2)\mathbf{i} + (2xy+2yz^2)\mathbf{j} + 2y^2z\,\mathbf{k}$
   Here c is a constant with the appropriate units.
   For the possible one, find the potential V(x,y,z), using the origin as your reference point. (10 %)

2. A uniformly charged spherical shell of radius R, carries total charge Q.
   (a) Find the electric field inside and outside the spherical shell. (10 %)
   (b) Find the potential inside and outside the spherical shell. (10 %)

3. A toroidal coil (螺旋環形線圈) with rectangular cross section (inner radius a, outer radius b, height h), which carries a total of n turns of current I .
   (a) Find the magnetic field of the toroid both inside and outside the coil. (10 %)
   (b) Find the self-inductance of the coil. (5 %)
   (c) Calculate the energy stored in the coil. (5 %)

4. Place a metal ring on top of a solenoidal coil (around an iron corn), turn on the current (flows conuterclockwise if view from the top of the coil) and plug metal ring in, then what will happen? And explain why. (10 %)



5. (a) Write down the differential form of the four Maxwell's equations in terms of free charges ρ_f and currents $\mathbf{J}_f$ for **E**, **B**, **D**, and **H** respectively. (10 %)
   (b) Derive the boundary conditions for these fields at the interface between two different media (medium 1 and medium 2), where the interface carries free charge density ρ_f or current density $\mathbf{K}_f$. (15 %)
   (c) In the case of linear media (medium 1 and medium 2), show the boundary conditions in terms of E and B alone. (5 %)